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Presumed killers? Vultures, stakeholders, misperceptions, and fake news

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Abstract

Vultures and condors are among the most threatened avian species in the world due to the impacts of human activities. Negative perceptions can contribute to these threats as some vulture species have been historically blamed for killing livestock. This perception of conflict has increased in recent years, associated with a viral spread of partial and biased information through social

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media and despite limited empirical support for these assertions. Here, we highlight that magnifying infrequent events of livestock being injured by vultures through publically shared videos or biased news items negatively impact efforts to conserve threatened populations of avian scavengers. We encourage environmental agencies, researchers, and practitioners to evaluate the reliability, frequency, and context of reports of vulture predation, weighing those results against the diverse and valuable contributions of vultures to environmental health and human well-being. We also encourage the development of awareness campaigns and improved livestock management practices, including commonly available nonlethal deterrence strategies, if needed. These actions are urgently required to allow the development of a more effective conservation strategy for vultures worldwide.

KEYWORDS

bird scavengers, Ecosystem services, human wildlife conflict, livestock predation

1 | INTRODUCTION

New and Old world obligate avian scavengers, condors and vultures (hereafter "vultures"), are among the most threatened birds in the world with 70% of species showing decreasing populations, mainly due to exposure to human-made toxicants (McClure et al., 2018; Plaza, Martínez-López, & Lambertucci, 2019). Most vulture species depend upon the carcasses of medium-to-large sized mammalian herbivores as a primary food-source. Depletion and extinctions of wild megafauna and wild ungulates have forced some of these species into relying almost exclusively on carcasses of domesticated ungulates used for livestock production (del Hoyo, Elliott, & Sargatal, 1994; Lambertucci et al., 2018). Due to this dependency, farming practices or sanitary legislation may affect vulture behavior, survival and population dynamics (Margalida & Colomer, 2012). Although the beneficial relationship between farmers and avian scavengers is well-known (Cortés-Avizanda, Donázar, & Pereira, 2015), the consumption of carcasses of domestic animals by vultures still results in perceived conflicts with farmers who blame them for killing their livestock (Ballejo, Plaza, & Lambertucci, 2020b; Duriez et al., 2019; Margalida, Campión, & Donázar, 2011). As a consequence, some people react with negative attitudes toward vultures, a response that may rapidly spread in some social contexts (e.g., social media, farmers meetings, newspaper reports, etc.).

Recognizing that some vulture species do kill livestock has been proposed as a better way of solving vulture–farmer conflict (e.g., Zuluaga et al., 2020), but this approach risks perpetuating a historical tendency to blame obligate scavengers as frequent killers. Here we, as scientists with long-term research experience on the ecology and behavior of scavengers in the New and Old World, argue that any conclusion on the relevance of vulture predation must be based on thorough empirical data collection and analyses and not just on anecdotal observations, often amplified by social media. Accordingly, we encourage environmental agencies, researchers, and practitioners to promote the collection and interpretation of detailed systematic field evidence to identify the frequency and context of any predation events that may occur. Further, we also call for weighing those results against the valuable contributions vultures make to human well-being. This will allow the development of more comprehensive and balanced conservation strategies for this endangered group of species and the ecosystem service they provide.

2 | HAVE VULTURES EVOLVED TO BE KILLERS?

The anatomical and physiological characteristics of vultures make them one of the most efficient species consuming dead animals, but at the same time limit their ability to kill live prey. The two main groups, New World (family Cathartidae) and Old World (family Accipitridae) vultures, are phylogenetically separated (Hackett et al., 2008) but have converged over several million years in many anatomical and physiological characteristics which give them superb performance as scavengers. They have large wings adapted for energetically efficient slow soaring rather than flying fast to chase prey (Ruxton & Houston, 2004), and visual adaptations to detect carcasses from large distances, which differ from those of predators

for prey capture (Potier, 2020). Their large body size allows them to carry greater body reserves to survive in extended periods where they do not find carcasses, which are ephemeral and patchily distributed (Ruxton & Houston, 2004; Spiegel, Harel, Getz, & Nathan, 2013). Unlike the grasping and piercing talons of hawks or eagles aim at catching prey, vultures feet and claws adapted to walk on the ground and hold the carrion while eating it. Moreover, they generally have bare skin in their heads and necks which help them to avoid feather contamination when blood and flesh build up when feeding and sticking their heads inside a carcass (Böhmer, Prevoteau, Duriez, & Abourachid, 2020; del Hoyo et al., 1994, see also the thermoregulatory function hypothesis in Ward, McCafferty, Houston, & Ruxton, 2008). Their physiological adaptations, such as a low stomach pH and stable intestinal microbiome, allow them to cope with potentially pathogenic microorganisms present in their diet of decomposing flesh (Beasley, Koltz, Lambert, Fierer, & Dunn, 2015; Plaza, Blanco, & Lambertucci, 2020). These anatomical and physiological traits make vultures very well adapted to eat carrion but not to kill, depending on this food source for their survival.

3 | DO VULTURES KILL?

Some vultures do occasionally kill animals, typically young and weak individuals (Avery & Cummings, 2004; Ballejo et al., 2020b; del Hoyo et al., 1994; Murn, 2014). However, this behavior is mostly occasional and does not imply that they are efficient predators or hunters that may represent a significant threat to livestock production. In the few cases where evidence suggested that vultures injured livestock, their limited abilities in this predatory role were illustrated by long handling times, most instances involving immobile, sick, weak, or abandoned lambs at, or soon after, birth and in livestock-rearing systems with poor animal husbandry (Ballejo et al., 2020b; Duriez et al., 2019; Margalida, Campión, & Donázar, 2014, authors personal observations). Those behaviors may also be associated with certain farming practices, and health policy regulations on carcass management, which affect the availability of food sources (Margalida et al., 2014; Zuberogoitia et al., 2010).

4 | CHRONIC MISPERCEPTIONS

Interactions between humans and scavenging birds have occurred since ancient times, but have changed through time, influenced by ecological and environmental conditions (Moleón et al., 2014). In popular culture, vultures have often been branded as malicious predators of livestock and even people (Figure 1). Indeed, a common name for the bearded vultures (*Gypaetus barbatus*) is Lammergeier, meaning "lamb vulture" in German. This depiction appears in many stories and novels, and other historical documents during the 19th and early 20th centuries, and contributed to the eradication of some species, such as bearded vultures and condors, from many regions of the World. Another paradigmatic example of how vultures were considered are stories like "The children of captain Grant in South America" from Jules Verne, where the protagonist is saved from the claws of an Andean condor (*Vultur gryphus*; Figure 1). Even when literature did not portray vultures as predators, it often fueled other negative perceptions. Dislike of vultures even comes from famous 18th century naturalists such as Buffon who wrote in his encyclopedia "Histoire Naturelle": "The vultures [...], gather in troops like cowardly murderers, and are rather thieves than warriors, birds of carnage than birds of prey; for in this kind there are only they who put themselves in numbers; only they are the ones that go after corpses, to the point of tearing them to the bone: corruption, infection attracts them instead of repelling them." (Leclerc de Buffon, 1749).

More recently, such negative old perceptions have emerged again mostly in some regions of Europe and the Americas, but also in Africa. They are mainly, but not exclusively, associated with griffon vultures (*Gyps fulvus*), black vultures (*Coragyps atratus*), and Andean condors. However, recent studies demonstrate that more than 70% of complaints about vultures attacking livestock in Spain and France were cases of those birds feeding on post-mortem individuals (Duriez et al., 2019; Margalida et al., 2014). In France, shepherds were not present in 95% of cases when the animal died so they cannot confidently attribute the deaths to vultures (Duriez et al., 2019). Similarly, >300 of observation hours on thousands of sheep in Patagonia indicate that the threatened Andean condors were involved in just one occasion where a lamb was injured mainly by black vultures. This event took more than 6 hours, highlighting how inefficient vultures are at killing (Ballejo, Plaza, & Lambertucci, 2020a,b).

5 | THE ECOLOGICAL ROLE AND SERVICES PROVIDED BY VULTURES

Vultures provide diverse positive contributions to people (IPBES, 2019), which are relevant to human health and well-being (O'Bryan et al., 2018). These include regulating services due to their carrion consumption ability,

FIGURE 1 Representations of vultures and condors attacking people were common a century ago and were even part of famous books (above right: Julio Verne's book cover). Currently, "fake news" and biased images and videos negatively affect again human perceptions about vultures worldwide but, in most cases, the images and observations correspond to birds cleaning the environment from placentas and dead animals after miscarried deliveries or afterbirth deaths surrounding livestock (picture below, photo by F. Ballejo)

other material, and non-material contributions favoring people's psychological and subjective well-being through cultural, recreational, and aesthetic services (Aguilera-Alcalá, Morales-Reyes, Martín-López, Moleón, & Sánchez-Zapata, 2020). For instance, by removing carcasses and other organic material from the environment they may limit the increase and spread of microorganisms, thereby providing disease regulation services (Plaza et al., 2020; Figure 2). The removal of carcasses by vultures saves millions of dollars globally and prevents greenhouse gas emissions produced by artificial carcass collection, transport and incineration (Grilli, Bildstein, & Lambertucci, 2019; Morales-Reyes et al., 2015). In addition, by consuming carcasses they may regulate populations of mesocarnivores and opportunistically scavenging pest species (Markandya et al., 2008; O'Bryan, Holden, & Watson, 2019; Ogada, Torchin, Kinnaird, & Ezenwa, 2012; Plaza et al., 2020).

Vultures also provide income from tourism as people travel to many places in the world to see them. Some examples are griffon vultures in Gamla Nature Reserve in Israel, and Massif Central upland in France, or Andean condors in the Colca Canyon in Perú, among many others. Therefore, reduction in their numbers would result in locally severe economic losses that come from ecotourism (e.g., Becker et al., 2005). Moreover, vultures provide beneficial non-material contributions to people by, for instance, enhancing human–wildlife connections through recreation activities in nature, aesthetic enjoyment, and learning (Aguilera-Alcalá et al., 2020; Cortés-Avizanda et al., 2015). These species are important religious and cultural symbols in several different parts of the world (Mundy, 1992; Donázar et al., 2016). Therefore, the benefits and contributions produced by vultures to the ecosystem as a whole, and to humans in particular,

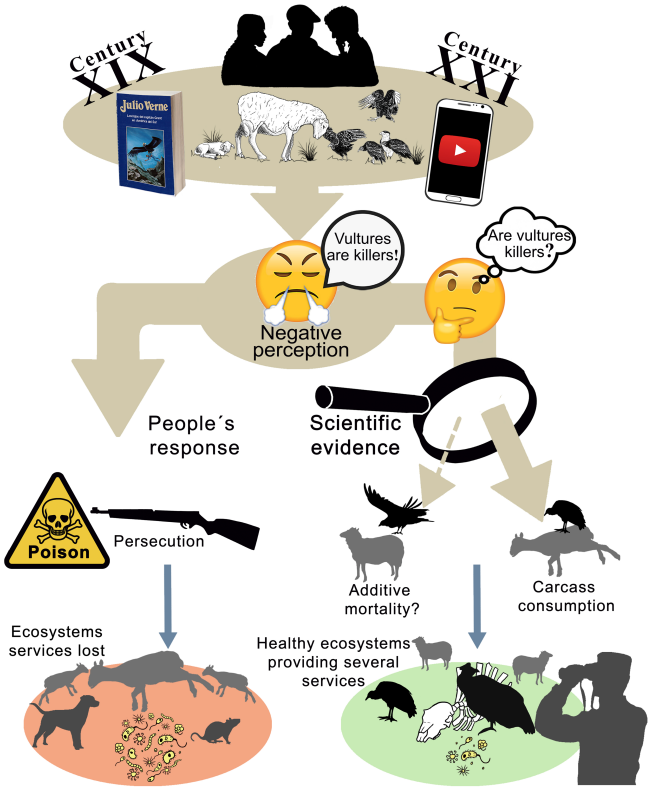

FIGURE 2 Historically, vultures were blamed for killing or persecuting wildlife and humans. Such negative perceptions can be inflamed or reinforced by biased and fake news accusing them for frequent livestock predation. Science has shown they are almost exclusively scavengers and that they provide important ecosystem services, including the potential reduction in pathogen and problematic species abundances, services that can be lost if they are persecuted to a significant population decline. There is still a need to systematically document and evaluate how many of those rare events actually correspond to additive mortality

cannot easily be replaced by other species. These benefits should be considered when evaluating their role in both natural and humanized ecosystems.

6 | THE RISK OF PROMOTING BIASED INFORMATION

Unfortunately, misinformed and false public opinion ("fake news") suggesting that vultures routinely act as livestock predators is common on social media (Margalida & Donázar, 2020). Negatively framed information about vultures may reach large audiences and affects people's responses and attitudes towards them (Ballejo, Plaza, & Lambertucci, 2021). For example, a video called "Vultures attack sheep" (https://youtu.be/840fKkBxHEE) showing a person talking about the number of sheep he has lost due to vultures has had more than 15K views (by February 2021). However, the same video was refuted by the Spanish authorities who collected information proving that the attack was produced by a carnivore, such as a dog, and that the vultures were just scavenging. Other items suggest attacks from vultures, but just show birds feeding on a carcass (e.g., https://youtu.be/H9gkALSHGbU). Unfortunately, the fake videos or those providing misinformation are still online several months later with the potential to perpetuate negative effects on new viewers and affecting viewers' perceptions of vultures (see more examples of this in: Ballejo et al., 2021).

Some items of partial or biased information occasionally turn "viral" (Lazer et al., 2018), and are often echoed by conventional news media (e.g., regional and national newspapers). This aggravates the problem, given the capacity and effectiveness of news media to spread news and drive opinion. Such stories facilitate the popularization of beliefs that are not in accord with available scientific evidence (Ballejo et al., 2020b, 2021; Margalida & Donázar, 2020) eventually increasing the negative perception of vultures. This may unfortunately lead to harmful actions by people, such as the use of poisons by farmers aiming to kill suspected predators, ultimately resulting in the death of many individuals of threatened and protected species (Margalida et al., 2011; Plaza et al., 2019). In areas where farmers receive economic compensation for cattle losses, lack of evidence on the mortality cause may enhance the conflict by easily attributing deaths to vultures. The dissemination of misinformation or fake news arises when informants ignore important contextual data such as the health of animals attacked, their birth circumstances, why they were not defended by their parents (new or sick mothers), what type of livestock husbandry was practiced in the area (e.g., unattended free-ranging), etc. Without such complementary key information, vultures may be blamed for losses that were likely to have occurred anyway.

7 | BUILDING A SCIENCE-BASED AGENDA

There is an urgent need to replace the dissemination of speculative stories that may compromise the conservation of threatened vultures with accurate information (Figure 3). It is essential for vulture conservation to conduct systematic assessments to understand the links between predation events by vultures according to farming practices. More research should be conducted to better understand whether these livestock deaths represent additional mortality or if vultures just bring forward the

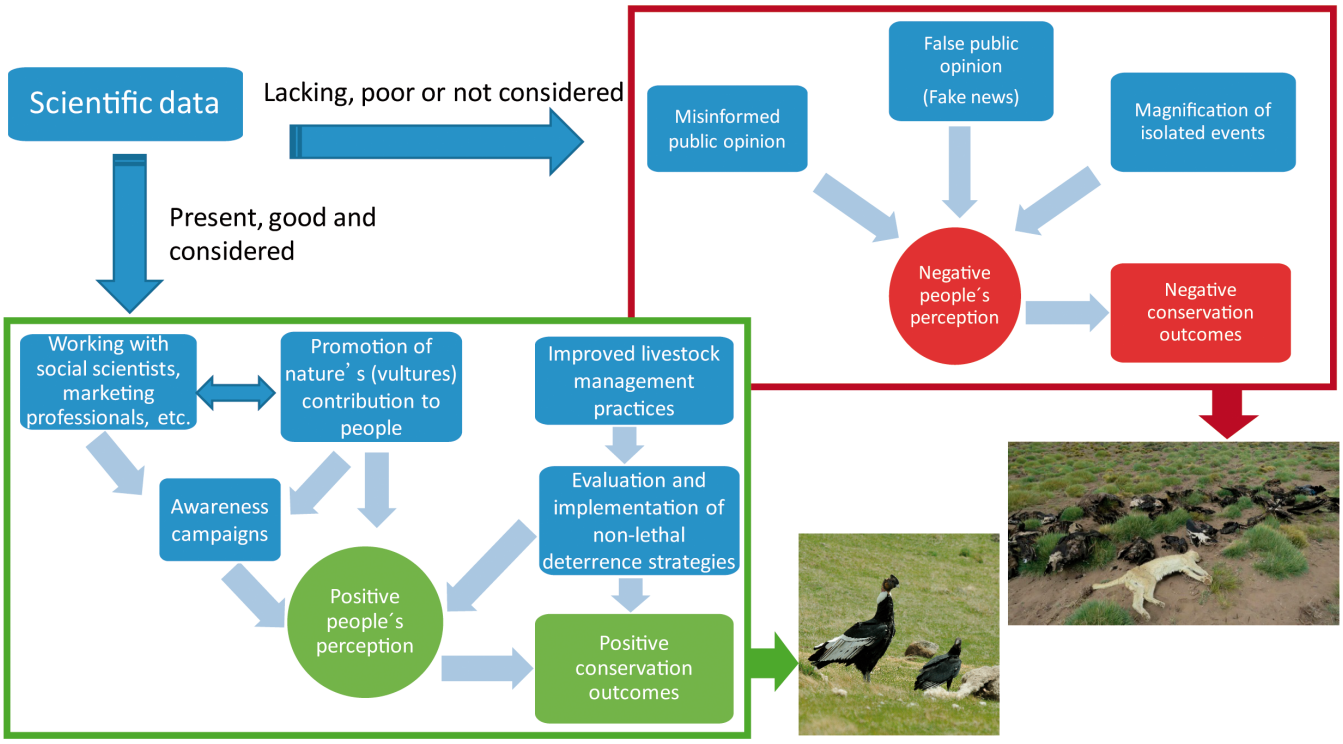

FIGURE 3 Potential scenarios of people perceptions on vultures depending on the availability and consideration (or the lack of) precise scientific socio-ecological information. We included examples of possible actions for disseminating available scientific information to obtain positive conservation outcomes

TABLE 1 Strategies proposed to reduce misinformation and false information on vultures classified for different stakeholders according to the need for involvement of each of them

	Strategy	Scientists	Biodiversity managers/NGOs	Farmers	Media	Policymakers
Reduce status quo bias	Gather field evidence					
	Design protocol to evaluate the cause of death					
	Using death cause protocol					
	Communicate evidence					
	Formal education					
	Informal education					
	Outreaching campaigns					
Reduce fake/miss-information news	Pass law wildlife news regulation/reviewing					
	Media content reviewing					

Note: The color indicates a different type of strategy. On the blue scale are strategies aiming to reduce cognitive bias (Cinner, 2018) and on the brown scale those aiming to reduce the spread of fake news or biased/misinformation content. The darker the color, the greater need for stakeholder involvement. Formal education: structured and systematic learning imparted by an institution following organized educational models and curricula. Informal education: unstructured learning, not occurring at an educational institution neither following a particular learning method or curricula.

time of deaths that would occur anyway. A standardized recording protocol after livestock death, as some countries already have (e.g., Spain), should be widely developed, adopted, and fulfilled before attributing the death to vultures, or any wild animal in general (Table 1). Ideally, the protocol should be carried out by federal or regional agents and include veterinarians specially trained with wildlife predation and not related to the farm owner (Duriez et al., 2019). However, this is not easy in all countries and areas where vultures occur.

Therefore, researchers, managers, and other stakeholders should be trained to do it and to collect evidence. Then, the results should be presented through round tables involving stakeholders.

Overall, the available scientific evidence suggests that the potential negative impact of vultures on livestock losses is slight and the benefits they provide to the farmers as well as to the overall ecosystem are substantial. Hence the regulating, material (e.g., provisioning), and non-material (e.g., cultural) contributions provided by avian scavengers should be properly quantified and communicated clearly to farmers to balance any negative effect they may occasionally cause. Any reduction in vulture's abundances may have profound net economic costs. An example of this is the important population declines produced by the use of the veterinary drug, diclofenac, in Asia (Green et al.2004), and the subsequent increase in feral dogs that might have produced a higher risk of rabies in humans from dog bites with costs of millions of dollars to counteract (Markandya et al., 2008). Similarly, in Africa, carcasses decomposition time and the presence of mesocarnivores increased in the absence of vultures (Ogada et al., 2012), with the consequent costs of having larger abundances of problem species (Figure 2) (O'Bryan et al., 2019). Therefore, to maintain those services and reduce conflict, improved livestock management practices that would allow reducing the chances of birds harming domestic animals should also be tested, as well as the implementation of nonlethal deterrence solutions in the case they occur (e.g., the use of guardian dogs, more presence of farmers in the field, etc. (Avery & Cummings, 2004; Ballejo et al., 2020a,b; Brink, Thomson, Amar, Girardello, & Santangeli, 2021; Duriez et al., 2019; Margalida et al., 2014).

Beyond the need for ecological knowledge (Figure 3), a better understanding of human-vulture relationships is needed to mitigate conflicts, as well as to support transition pathways promoting coexistence and mutual benefits (Gangoso et al., 2013). To better address the conflict, it will be important to evaluate the extant level of conflict (Zimmermann, McQuinn, & Macdonald, 2020). This should be done for each species and area since the success of the strategies will differ depending on the level of conflict. Such an evidence-based approach would highlight any real problems and suggest better practices to reduce any conflict. After management strategies are implemented, their effectiveness for reducing the perceived human–wildlife conflict should be evaluated to assess if they facilitate vulture–farmer coexistence.

8 | COMMUNICATION

Together with obtaining scientific data, it would be beneficial to understand the cognitive biases and social influences (Cinner, 2018) affecting human perceptions of vultures. This is particularly important when developing two key approaches to vulture conservation: (1) disseminating accurate scientific information about the ecological role of vultures, including the services they provide and the vulture–human conflict, and (2) reducing the spread of misinformation and fake news. If we are to avoid the present situation in which news stories tend to confirm prejudices and biases, the knowledge gathered through collaborations between biologist, veterinarians, and social scientists should be obtained and then actively communicated. This should include inclusion in the curricula of formal education and through informal education, such as outreach campaigns (Table 1).

Awareness-raising campaigns in areas of high conflict (i.e., where negative perceptions are widespread) should be designed according to the level and type of conflict in the area concerned. Education and dissemination campaigns (Table 1) have already started in many areas where vultures occur, and should be encouraged in areas where vultures may expand their distribution to reduce the risk of misperceptions (Duriez et al., 2019). One valuable type of activity is the "international vulture awareness day" (https://www.vultureday.org/), which is celebrated annually and includes activities aiming at improving people´s knowledge about vulture ecology and conservation problems. Such awareness campaigns should include updated scientific information on the important role of obligate scavengers in the local ecosystem. They also need to highlight the role of improved farming practices in preventing vulture–farmer conflict, including nonlethal remedial actions if any additional mortality occurs.

The wide-reach and strong influence of social media should be used to spread accurate information. Some communication strategies could be better carried out by pro-vulture farmers as ambassadors and knowledge-spreaders given people tend to do what others do in their social environment (Cinner, 2018). The collaboration among biologists, social scientists, marketing professionals, educators, farmers and media will be essential for minimizing negative perceptions of vultures (Figure 3; Table 1). In this way, the information produced for awareness campaigns would reach the specific audience needed in the right way. For example, it is important to inform people that if scavenger abundance is reduced there is a high probability of increase of problems from other species, such as mesopredators (O'Bryan et al., 2019), increases in pathogens, and consequently a potential increment of health problems (Plaza et al., 2020). Communicating these alternative outcomes is important because people are sensitive to reports of negative outcomes such as economic losses and impacts on human health (Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001; Cinner, 2018).

9 | CONCLUDING REMARKS

Vultures are not efficient at preying on live animals and it takes much time and effort for them to do so. This makes solutions to potential problems through sustainable livestock husbandry practices relatively easy to identify (Ballejo et al., 2020b). For example, maintaining and promoting traditional extensive farming linked to experience-based and local ecological knowledge drives positive perceptions of scavengers and the recognition of the services they provide (Cortés-Avizanda et al., 2015; Morales-Reyes et al., 2018). However, despite several measures towards reducing this conflict can be implemented, it is also important to avoid the spread of unsubstantiated or exaggerated information that influence people´s perception and have negative conservation outcomes (Table 1; Figure 3). Fake news and misinformation have proven to be very dangerous in influencing public perceptions and actions, and their effects are difficult to reverse (Lazer et al., 2018). Therefore, there should be careful checking of media content, not to censor stakeholders but to prevent misinformation and fake news that may negatively affect threatened species (Table 1).

We call upon media, politicians, farmers, and also scientists to be cautious and to avoid magnifying isolated events through publishing videos or biased news, given the highly detrimental effect on the conservation of vultures (Figure 3). The media itself has a responsibility and capacity to stop spreading false news, but continues to do so in certain countries (e.g., Spain, France, Argentina) without checking the sources of information. It is important for conservationists and NGOs working in conservation to include this topic in their campaigns. To increase support by media and politician and stakeholders, ornithologists should invite key-stakeholders to the field to see vulture feeding behavior and explain how it can easily be misinterpreted. Local experience in France proved that once a few influential stakeholders are convinced about vulture benefits, they can become "vulture ambassadors" and greatly help solving conflicts. We hope this call will encourage researchers and managers to actively seek additional field evidence evaluating the extent to which human perceptions correspond to actual impacts, and for assessing those impacts against the benefits of vultures and condors to people´s wellbeing and to the health of the overal ecosystem. This information will greatly help in the development of the most appropriate conservation strategies to recover avian scavenger populations worldwide, harmonizing the previous long-established mutual relationship between farmers and vultures.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Sergio A. Lambertucci drafted the idea and the article after discussing and including suggestions from all authors that contributed to further drafts and development of concepts.

DATA AVAILABILITY STATEMENT

This article contains no data.

ETHICS STATEMENT

No animals were used in this study.

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REFERENCES

Aguilera-Alcalá, N., Morales-Reyes, Z., Martín-López, B., Moleón, M., & Sánchez-Zapata, J. A. (2020). Role of scavengers in providing non-material contributions to people. *Ecological Indicators*, *117*, 106643.

Avery, M. L., & Cummings, J. l. (2004). Livestock depredations by black vultures and golden eagles. *Sheep & Goat Research Journal*, *19*, 58–63.

Ballejo, F., Plaza, P., & Lambertucci, S. A. (2021). Framing of visual content shown on popular social media can affect viewers' attitudes to threatened species. *Research Square* (Preprint accessed March 2, 2021). https://doi.org/10.21203/rs.3.rs-267841/v1

Ballejo, F., Plaza, P. I., & Lambertucci, S. A. (2020a). The productive, ecological, and perception problem of the "unacceptable" livestock losses due to scavenger birds. *Biological Conservation*, *250*, 108723.

Ballejo, F., Plaza, P. I., & Lambertucci, S. A. (2020b). The conflict between scavenging birds and farmers: Field observations do not support people's perceptions. *Biological Conservation*, *248*, 108627.

Baumeister, R. F., Bratslavsky, E., Finkenauer, C., & Vohs, K. D. (2001). Bad is stronger than good. *Review of General Psychology*, *5*, 323–370.

Beasley, D. E., Koltz, A. M., Lambert, J. E., Fierer, N., & Dunn, R. R. (2015). The evolution of stomach acidity and its relevance to the human microbiome. *PLoS One*, *10*, e0134116.

Becker, N., Inbar, M., Bahat, O., Choresh, Y., Ben-Noon, G., & Yaffe, O. (2005). Estimating the economic value of viewing griffon vultures *Gyps fulvus*: A travel cost model study at Gamla nature reserve, Israel. *Oryx*, *39*, 429–434.

Böhmer, C., Prevoteau, J., Duriez, O., & Abourachid, A. (2020). Gulper, ripper and scrapper: Anatomy of the neck in three species of vultures. *Journal of Anatomy*, *236*, 701–723.

Brink, C. W., Thomson, R. L., Amar, A., Girardello, M., & Santangeli, A. (2021). Prevalence and drivers of poison use by south African commercial farmers and perceptions of alternative livestock protection measures. *Ambio*. https://doi.org/10.1007/s13280-020-01461-2

Cinner, J. (2018). How behavioral science can help conservation. *Science*, *362*, 889–890.

Cortés-Avizanda, A., Donázar, J. A., & Pereira, H. M. (2015). Top scavengers in a wilder Europe. In H. M. Pereira & L. Navarro (Eds.), (pp. 85–106). Rewilding European landscapes: Springerr.

del Hoyo, J., Elliott, A., & Sargatal, J. (1994). *Handbook of the birds of the WorldLynx Edicions*. Barcelona: Lynx Edicions.

Donázar, J. A., Cortés-Avizanda, A., Fargallo, J. A., Margalida, A., Moleón, M., Morales-Reyes, Z., … Serrano, D. (2016). Roles of raptors in a changing world: From flagships to providers of key ecosystem services. *Ardeola*, *63*, 181–234.

Duriez, O., Descaves, S., Gallais, R., Neouze, R., Fluhr, J., & Decante, F. (2019). Vultures attacking livestock: A problem of vulture behavioural change or farmers' perception? *Bird Conservation International*, *29*, 437–453.

Gangoso, L., Agudo, R., Anadón, J. D., de la Riva, M., Suleyman, A. S., Porter, R., & Donázar, J. A. (2013). Reinventing mutualism between humans and wild fauna: Insights from vultures as ecosystem services providers. *Conservation Letters*, *6*, 172–179.

Green, R. E., Newton, I., Shultz, S., Cunningham, A. A., Gilbert, M., Pain, D. J., & Prakash, V. (2004). Diclofenac poisoning as a cause of vulture population declines across the Indian subcontinent. *Journal of Applied Ecology*, *41*, 793–800.

Grilli, M. G., Bildstein, K. L., & Lambertucci, S. A. (2019). Nature's clean-up crew: Quantifying ecosystem services offered by a migratory avian scavenger on a continental scale. *Ecosystem Services*, *39*, 100990.

Hackett, S. J., Kimball, R. T., Reddy, S., Bowie, R. C., Braun, E. L., Braun, M. J., … Harshman, J. (2008). A phylogenomic study of birds reveals their evolutionary history. *Science*, *320*, 1763–1768.

IPBES (Intergovernmental Science-Policy Platform on Biodiversity). (2019). *Summary for policymakers of the global assessment report of the Intergovernmental Science-Policy Platform on Biodiversity and ecosystem services*. Bonn: IPBES Secretariat.

Lambertucci, S. A., Navarro, J., Sanchez Zapata, J. A., Hobson, K. A., Alarcón, P. A. E., Wiemeyer, G., … Donázar, J. A. (2018). Tracking data and retrospective analyses of diet reveal the consequences of loss of marine subsidies for an obligate scavenger, the Andean condor. *Proceedings of the Royal Society B: Biological Sciences*, *285*, 1–7.

Lazer, D. M. J., Baum, M. A., Benkler, Y., Berinsky, A. J., Greenhill, K. M., Menczer, F., … Zittrain, J. L. (2018). The science of fake news. *Science*, *359*, 1094–1096.

Leclerc de Buffon, G.-L. (1749). Les vautours. In *Page 146 Histoire Naturelle des oiseaux*. Imprimerie Royale, Paris: France.

Margalida, A., Campión, D., & Donázar, J. A. (2011). European vultures' altered behaviour. *Nature*, *480*, 457–457.

Margalida, A., Campión, D., & Donázar, J. A. (2014). Vultures vs livestock: Conservation relationships in an emerging conflict between humans and wildlife. *Oryx*, *48*, 172–176.

Margalida, A., & Colomer, M. À. (2012). Modelling the effects of sanitary policies on European vulture conservation. *Scientific Reports*, *2*, 753.

Margalida, A., & Donázar, J. A. (2020). Fake news and vultures. *Nature Sustainability*, *3*, 492–493.

Markandya, A., Taylor, T., Longo, A., Murty, M. N., Murty, S., & Dhavala, K. (2008). Counting the cost of vulture decline—An appraisal of the human health and other benefits of vultures in India. *Ecological Economics*, *67*, 194–204.

McClure, C. J. W., Westrip, J. R. S., Johnson, J. A., Schulwitz, S. E., Virani, M. Z., Davies, R., … Butchart, S. H. M. (2018). State of the world's raptors: Distributions, threats, and conservation recommendations. *Biological Conservation*, *227*, 390–402.

Moleón, M., Sánchez-Zapata, J. A., Margalida, A., Carrete, M., Owen-Smith, N., & Donázar, J. A. (2014). Humans and scavengers: The evolution of interactions and ecosystem services. *Bioscience*, *64*, 394–403.

Morales-Reyes, Z., Martín-López, B., Moleón, M., Mateo-Tomás, P., Botella, F., Margalida, A., … Sánchez-Zapata, J. A. (2018). Farmer perceptions of the ecosystem services provided by scavengers: What, who, and to whom. *Conservation Letters*, *11*, e12392.

Morales-Reyes, Z., Pérez-García, J. M., Moleón, M., Botella, F., Carrete, M., Lazcano, C., … Sánchez-Zapata, J. A. (2015). Supplanting ecosystem services provided by scavengers raises greenhouse gas emissions. *Scientific Reports*, *5*, 7811.

Mundy, P., Butchart, D., Ledger, J., & Piper, S. (1992). *The vultures of Africa*. London: Academic Press.

Murn, C. (2014). Observations of predatory behavior by white-headed vultures. *Journal of Raptor Research*, *48*, 297–299.

O'Bryan, C. J., Braczkowski, A. R., Beyer, H. L., Carter, N. H., Watson, J. E. M., & McDonald-Madden, E. (2018). The contribution of predators and scavengers to human well-being. *Nature Ecology & Evolution*, *2*, 229–236.

O'Bryan, C. J., Holden, M. H., & Watson, J. E. M. (2019). The mesoscavenger release hypothesis and implications for ecosystem and human well-being. *Ecology Letters*, *22*, 1340–1348.

Ogada, D. L., Torchin, M. E., Kinnaird, M. F., & Ezenwa, V. O. (2012). Effects of vulture declines on facultative scavengers and potential implications for mammalian disease transmission. *Conservation Biology*, *26*, 453–460.

Plaza, P. I., Blanco, G., & Lambertucci, S. A. (2020). Implications of bacterial, viral, and mycotic microorganisms in vultures for wildlife conservation, ecosystem services and public health. *Ibis*, *162*, 1109–1124.

Plaza, P. I., Martínez-López, E., & Lambertucci, S. A. (2019). The perfect threat: Pesticides and vultures. *Science of the Total Environment*, *687*, 1207–1218.

Potier, S. (2020). Visual adaptations in predatory and scavenging diurnal raptors. *Diversity*, *12*, 400.

Ruxton, G. D., & Houston, D. C. (2004). Obligate vertebrate scavengers must be large soaring fliers. *Journal of Theoretical Biology*, *228*, 431–436.

Spiegel, O., Harel, R., Getz, W. M., & Nathan, R. (2013). Mixed strategies of griffon vultures' (*Gyps fulvus*) response to food deprivation lead to a hump-shaped movement pattern. *Movement Ecology*, *1*, 5.

Ward, J., McCafferty, D. J., Houston, D. C., & Ruxton, G. D. (2008). Why do vultures have bald heads? The role of postural adjustment and bare skin areas in thermoregulation. *Journal of Thermal Biology*, *33*, 168–173.

Zimmermann, A., McQuinn, B., & Macdonald, D. W. (2020). Levels of conflict over wildlife: Understanding and addressing the right problem. *Conservation Science and Practice*, *2*, e259.

Zuberogoitia, I., Martínez, J. E., Margalida, A., Gómez, I., Azkona, A., & Martínez, J. A. (2010). Reduced food availability induces behavioural changes in Griffon Vulture *Gyps fulvus*. *Ornis Fennica*, *87*, 52–60.

Zuluaga, S., Salom, A., Vargas, F. H., Coulson, J. O., Kohn, S., & Grande, J. M. (2020). Acknowledging Andean Condor predation on livestock, a first step in addressing the human-condor conflict: A commentary to Estrada Pacheco et al. (2020). *Biological Conservation*, *247*, 108618.

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